



# Assessing the Development of ASL by Deaf Children: Longitudinal Spontaneous Production Data

Diane Lillo-Martin<sup>1</sup>, Linghui Eva Gan<sup>1</sup>, Julie Hochgesang<sup>2</sup>, Deborah Chen Pichler<sup>2</sup>

<sup>1</sup>University of Connecticut; <sup>2</sup>Gallaudet University



# Background

- Measures of early sign language development serve multiple purposes:
  - Understanding of the course of acquisition for languages in the visual modality
  - Tracking of acquisition progress for children with different early experiences
- Preference for use of measures that can be applied to children in many different environments

# LSA

## Language Sample Analysis

- Language samples are a common method of data collection
- Possible to obtain longitudinal naturalistic data
- Low burden on child; high ecological validity
- High burden on assessor
  - Detailed annotation
  - Linguistic analysis

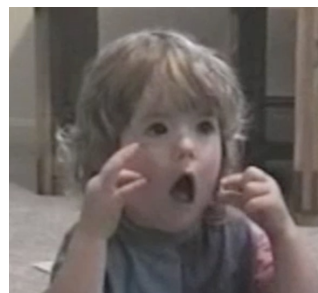


# Participants

*SLAAASh Database (UConn)*



Child	Number of Sessions analyzed		Beginning Age (months)	Ending Age (months)
	100 utterances	50 utterances		
ABY	24	21	17	39
JIL	23	(N/A)	21	43
NED	18	23	23	50
SAL	6	6	19	34





# Language Samples

## Data collection

- Children interacted with their parent(s) and/or signing research assistants (some deaf, some hearing)
- Sessions include playing with toys, eating snacks, looking at books, etc.
- Each session roughly 1 hour



# Language Samples Annotation

Sessions annotated in ELAN  
using ID glosses from [ASL  
Signbank](#) and the [SLAAASH  
project](#) conventions  
(Hochgesang 2022)

The screenshot displays the ELAN 6.7 software interface for video annotation. The top window shows a video of a woman and a child sitting at a table. The right-hand window displays a detailed ASL glossing window for 'Child ASL right hand', showing a list of glosses such as 'IX\_1 · WITH · NS · NS · ALL · MANY · ALL · ALL · IX\_1 · WITH · NS · IX\_1 · WITH · NS · SAME-AS · WHITE · SAME-AS · IX · TWO · NS · TWO · TWO · SAME-AS · IX\_1 · WHITE · SAME-AS · NS · SAME-AS · WITH · MARRYstr · HUSBAND · NS · WITH · DANCE · HUG · DS\_s · DANCE · RECENTlex · IX\_1 · FATHERstr · CAMERA · MOTHERstr · DANCE · FS · BLOUSE · DS\_c · WHITE · RED · MOTHERstr · SAYstr · SAYstr · POSS\_1 · FAVORITE · POSS\_1 · FAVORITE · DS\_of · YYY · SMALL · SHOES · SMALL · STUBBORN · PU · SAME-AS · WITH · FATHERstr · IXarc · FUTUREstr · PU · WITH · NS · GIRL · NS · NS · WIFE · i(hmm) · GIRL · YYY · GO-AWAY · HOUSE · GIRL · WORK · LONG · GIRL · YYY · SLOW · &=hills-leg · PURPLE · NS · PROVIDE · POSS\_1 · GIRL · i(oops) · IX · &=claps · &=claps · SAD · CRY · SAD · SAD · SAD · SAD · IX · COME-HERE · HAPPY · IX · SAD · HAPPY · HAPPY · SAD · YYY · HAPPY · SAD · SAD · CRY · CRY · MORE · NO · CAR · OTHER · SAME-AS · BECKON · WHATbo · BECKON · IX · IX\_1 · DS\_of · IX · DS\_of · IX\_1 · IX\_1 · IX · IX · ONE · FALLb · ONE · &=claps · IX · &=claps · IX · CORNER · IX · IX · BECKON · TELEPHONE · IX · IX · TWO · IXarc · TWO · FAIL · IX · FALLb · FALLb · THROWS · THROWS · IX · THROWS · THROW · IX · IX · DS\_c · &=pats-table · DS\_c · DS\_c · THAT · IX · CATCHs · WRONG · IX\_1 · MAKE-MISTAKE · IX · &=claps · &=pats-table · MORE · &=pats-table · WRONG · WRONG · &=claps · &=claps · MORE · i(oops) · IX · &=claps · YES · WRONG · COME-ON · WAIT-ONE-MINUTE · IX · DS\_fo · YYY · IX · PUT-IN · STOP · PUT-IN · IX · WRONG · DS\_2 · FALLb · WRONG · SELF · FALLb · &=claps · &=pats-table · IX\_1 · BLOW · IX\_1 · WRONG · IX\_1 · BLOW · IX · WHY · IX · &=claps · IX · &=claps · IX · CLOSE-BOOK · WAIT-ONE-MINUTE · BOY · GIRL · IX · WARN · DOGelan · IX · FROGch · WAIT-ONE-MINUTE · PU · IX · IX · TOMORROW ·

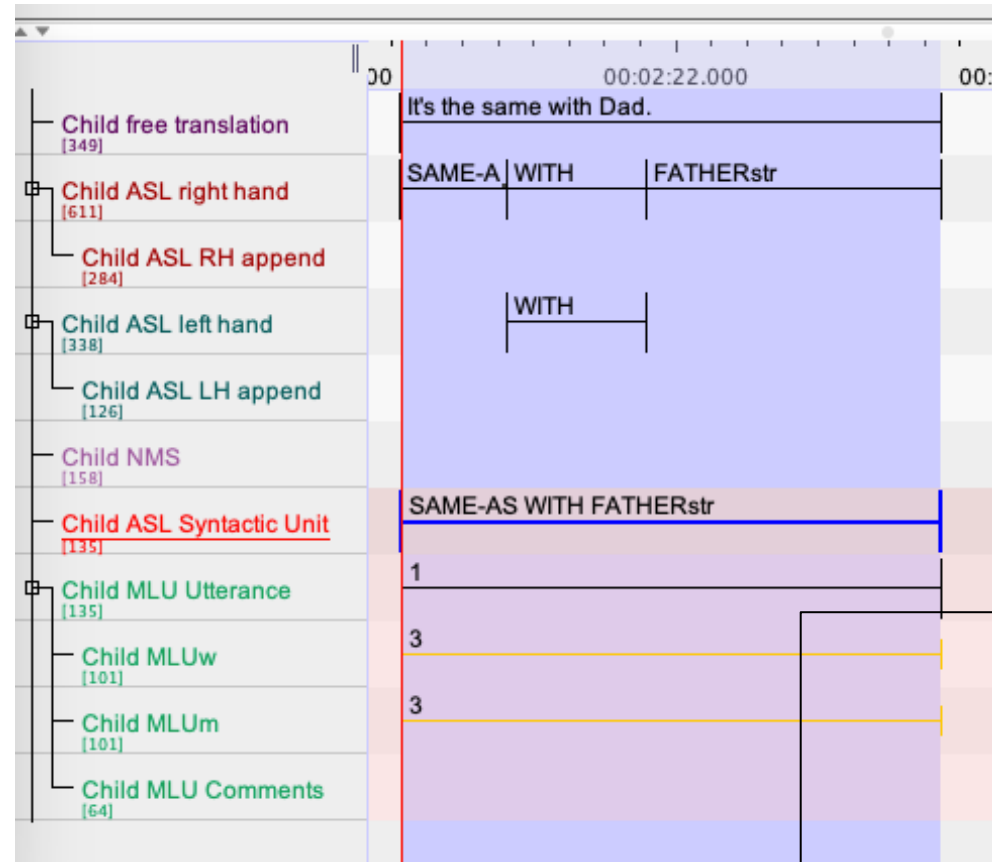
The bottom window shows a timeline of annotations with various layers including Comments, Adult1 ASL right hand, Adult1 ASL left hand, Adult1 NMS, Adult1 English utterance, Child ASL Syntactic Unit, Child MLUw, Child MLU, Child MLU Comments, Child free translation, Child ASL right hand, Child ASL RH append, Child ASL left hand, Child ASL LH append, Child NMS, and Child English utterance. The timeline is marked with time points from 00:01:04.388 to 00:01:07.01.



Hochgesang 2022, 'SLAASH  
ID glossing Principles, ASL  
Signbank and Annotation  
Conventions'

# Syntactic Units

- ELAN Transcript is divided into **Syntactic Units (SU)**
- Use a preponderance of evidence from **Syntax**, **Semantics**, and **Prosody** to help determine what is a single Syntactic Unit



# ASL IPSyn

- Adapted from English [Index of Productive Syntax](#) (Scarborough 1990)
- English version is widely used across studies of many different populations

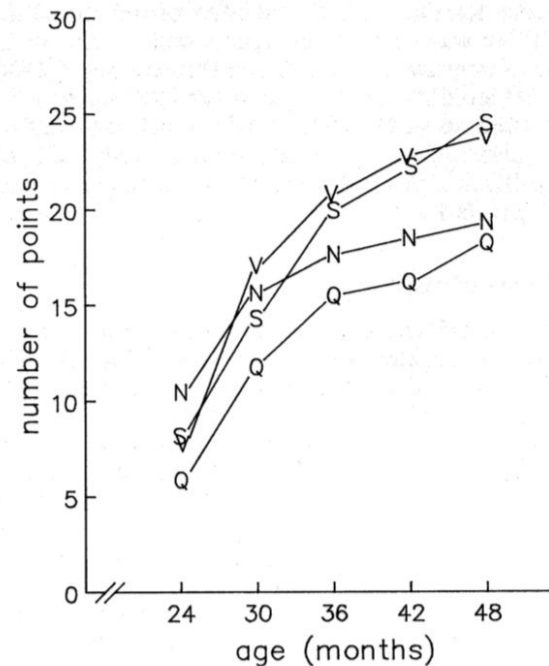


Figure 2. Age changes in IPSyn subscales for noun phrases (N), verb phrases (V), questions/negations (Q), and sentence structures (S).

# ASL IPSyn

## Subscales

- Common ASL morpho-syntactic structures in 5 subscales

	Subscale	Structures included
1	Noun	Nouns, pronouns, adjectives, plurals, etc.
2	Verb	Verbs, adverbs, aspect, modals, agreement, etc.
3	<i>Depiction</i>	<i>SASS, whole entity, handling, constructed action, etc.</i>
4	Question/Negation	WH-words, polar questions, negators, doubling, NMM, etc.
5	Sentence	Word order, sentence types, etc.



UConn Sign Linguistics &  
Language Acquisition Lab,  
Instruments, Item 10

# ASL IPSyn

## The scoresheet

### Depiction Subscale

Item	Brief Description	Example	Also credit
D1	Size & Shape specifier <SASS>	DS_f(thin-horizontal-tube)	
D2	Entity	DS_3(car-driving-uphill)	
D3	Handling	DS_s(brushing-teeth)	

### Question/Negation Subscale

Item	Brief Description	Example	Also credit
Q1	Early wh-word	WHAT (any form); WHERE	
Q2	Late wh-word	WHO; WHY; HOW; WHEN	
Q3	wh-word ~ IX	WHAT IX; IX WHO	Q1 or Q2

# ASL IPSyn

## Scoring

- Assessor searches for up to 2 instances of each structure from the language sample (If none, 0 points; if 1 instance, 1 point; if 2 instances, 2 points)



•Example:

•Verb type subscale

Item	Brief Description	Also credit	Exemplar 1 Time	Exemplar 1	Exemplar 2 Time	Exemplar 2	Total
V1	VERB						0
V2	VERB[location modification]	V1					0
V3	VERB[person modification]	V1					0

- Using 100 Syntactic Units in ELAN (ASL IPSyn versions 1-2; Lillo-Martin et al. 2017) or 50 Syntactic Units (ASL IPSyn version 3; Lillo-Martin et al. in prep)

# NDW

## Number of Different Words

- Each session evaluated for **lexical types**, based on annotation entries from **ASL Signbank** ([aslsignbank.haskins.yale.edu](http://aslsignbank.haskins.yale.edu))
- Using 'View Annotation Statistics' function in ELAN, exported all individual sign entries and counted each type
- Note: Vocabulary size is related to session length, which varies

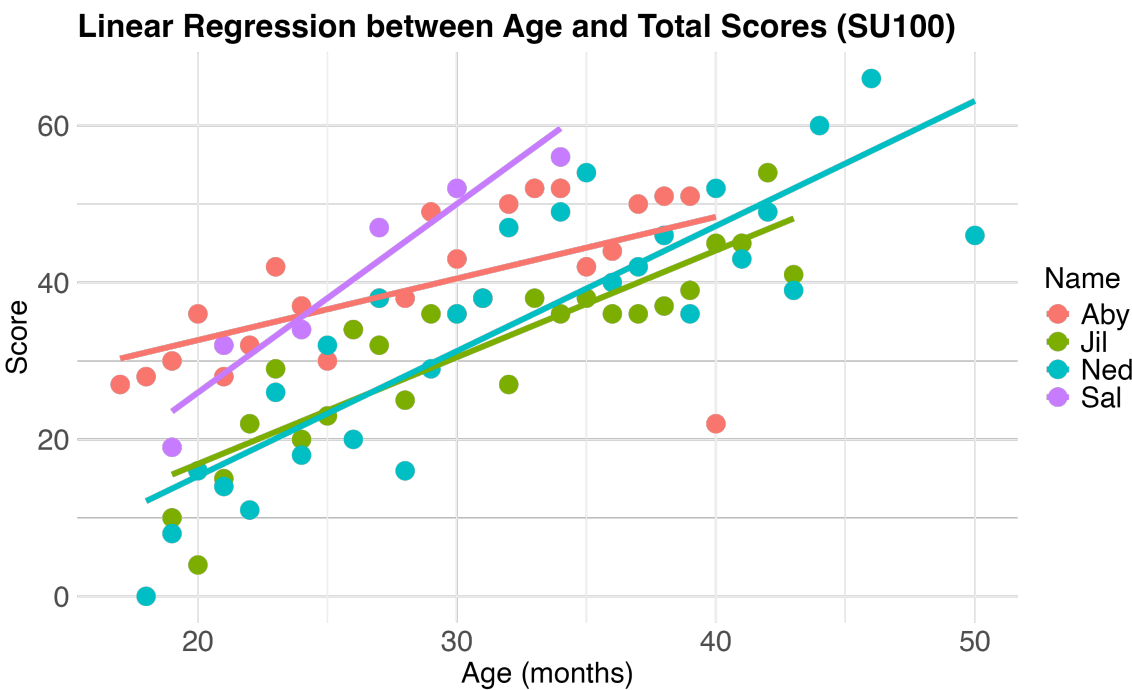
Statistics Variables	
Annotation	Occurrences
FINISH	2
FLASH	2
FROWNix	2
JUMPup	2
PLAY	2
BIGix	3
DRUM	3
LONG	3





# Results: IPSyn Total Score

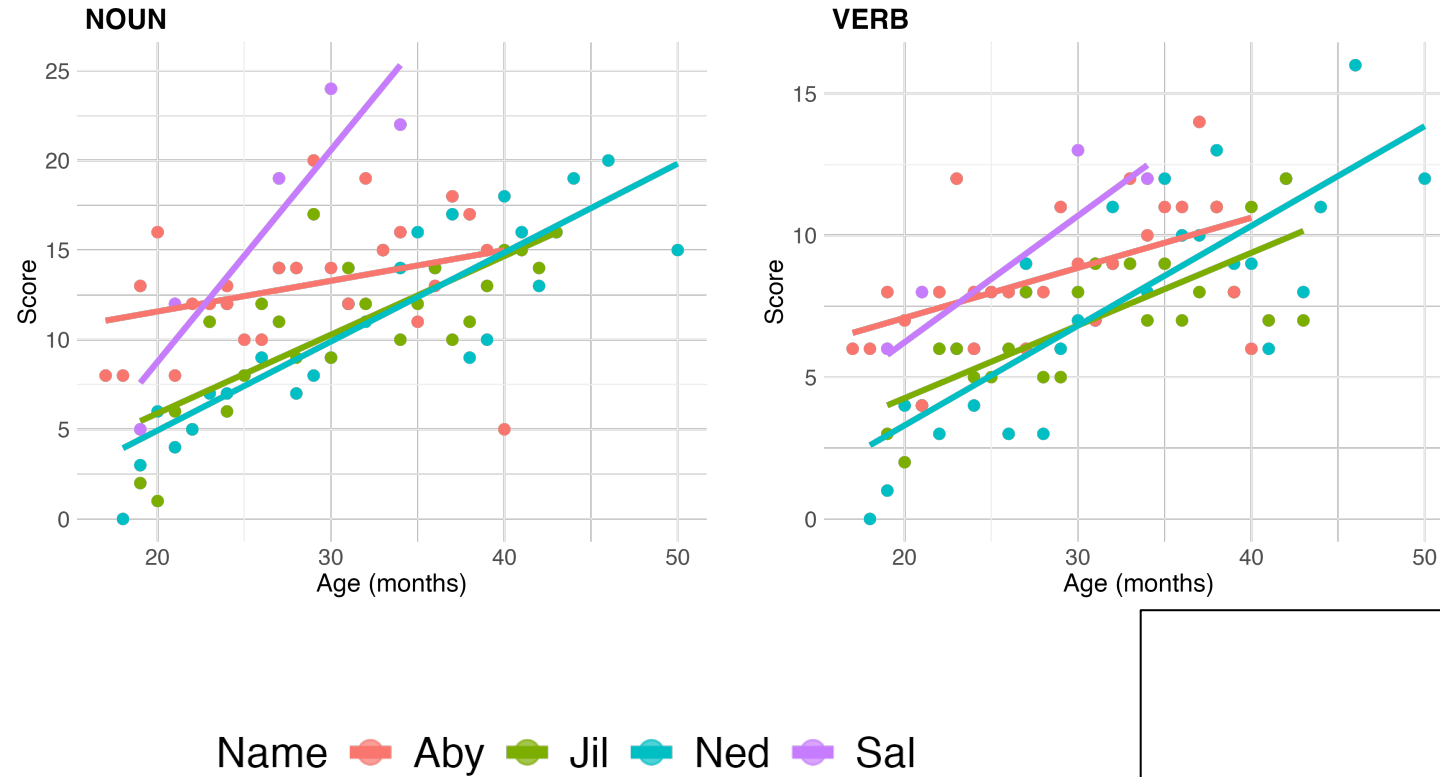
- ASL-IPSyn (SU100) overall scores increase with age
- Linear regression model – lm()



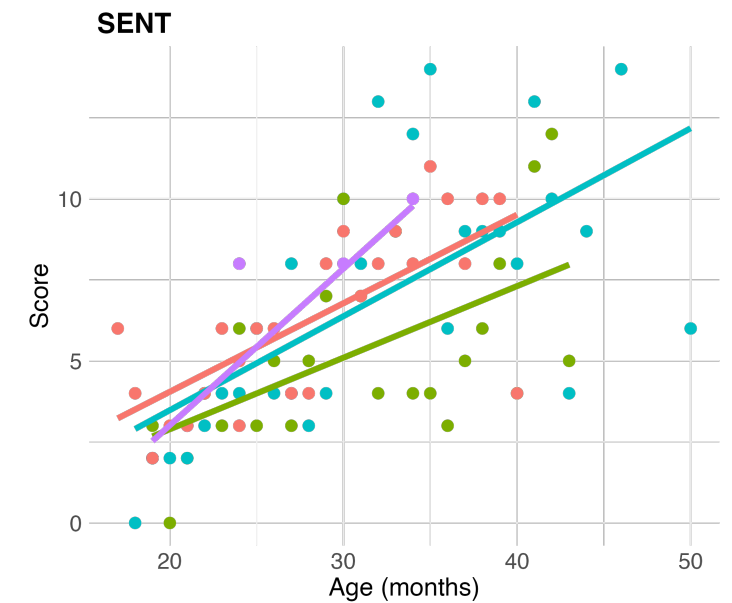
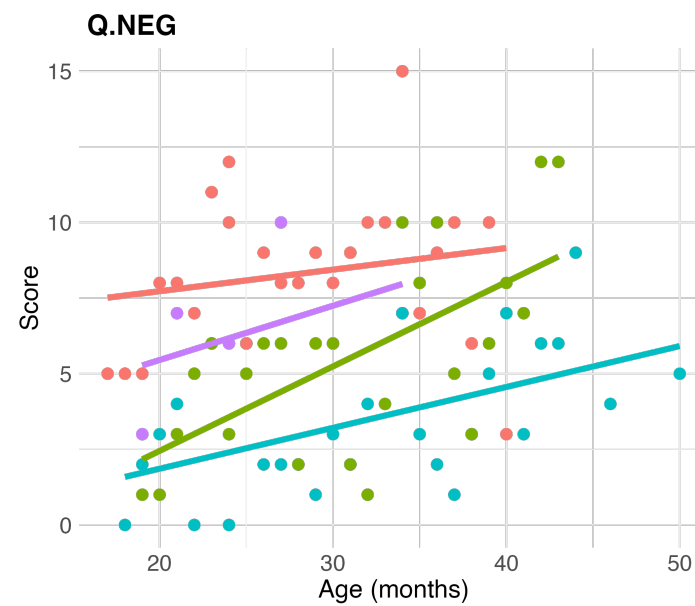
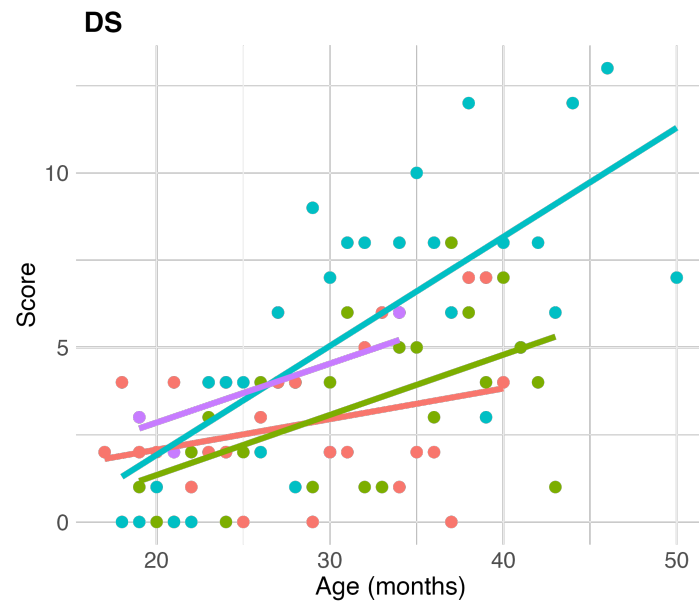
Linear Regression between Age and IPSyn Total Score (SU100)					
	df	n	r	t-value	p-value
ABY	22	24	0.603	3.544	0.002
JIL	23	25	0.876	8.711	<.001
NED	26	28	0.859	8.555	<.001
SAL	4	6	0.963	7.18	0.002

# Results: IPSyn subscale scores (NOUN & VERB)

- A similar pattern of score increase can be seen in all of the subscales



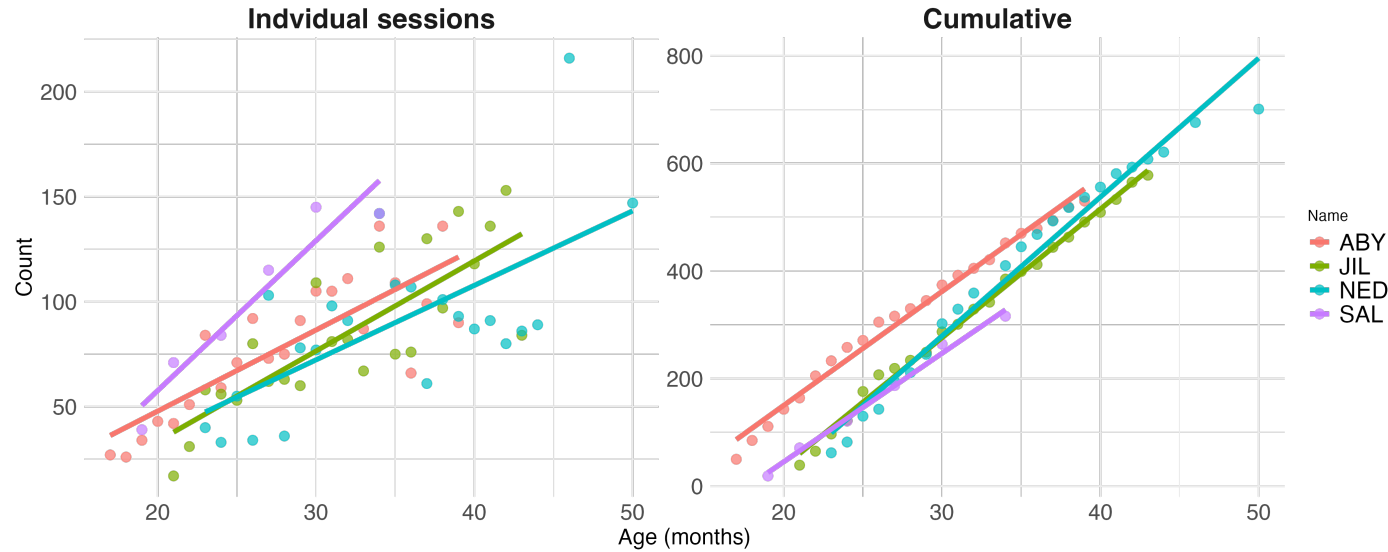
# Results: IPSyn subscale scores (DS, Q/NEG, SENTENCE)



Name Aby Jil Ned Sal

# Results: Vocabulary

Linear Regression between Age and Vocabulary (lm)



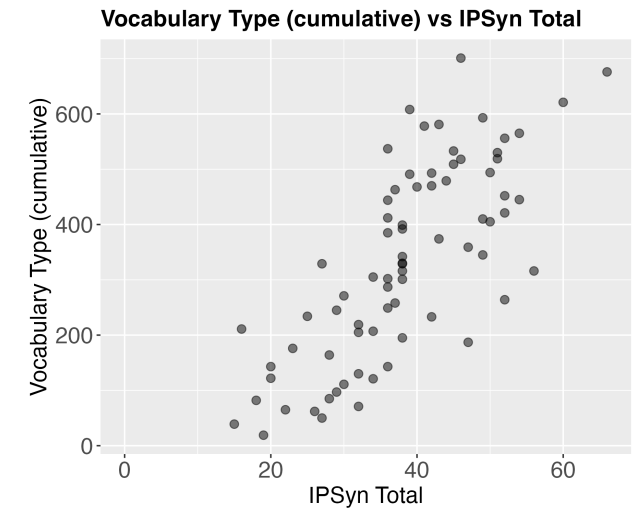
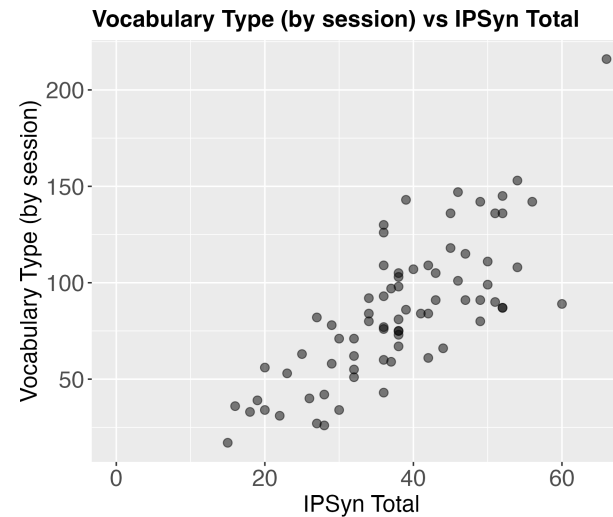
- Vocabulary (NDW) increases with age, by session and cumulatively

Linear Regression between Age and Vocabulary Types (lm)

	df	Individual sessions		Cumulative	
		r	p	r	p
<b>ABY</b>	21	0.822	<.001	0.993	<.001
<b>JIL</b>	21	0.810	<.001	0.997	<.001
<b>NED</b>	21	0.658	<.001	0.987	<.001
<b>SAL</b>	4	0.958	0.003	0.996	<.001

# Linear Regression between IPSyn and Vocabulary

- ASL-IPSyn (100 utterances) is strongly and significantly related to vocabulary.
- lmer( )
  - IPSyn.total ~ Vocab type
  - Participant as random effect

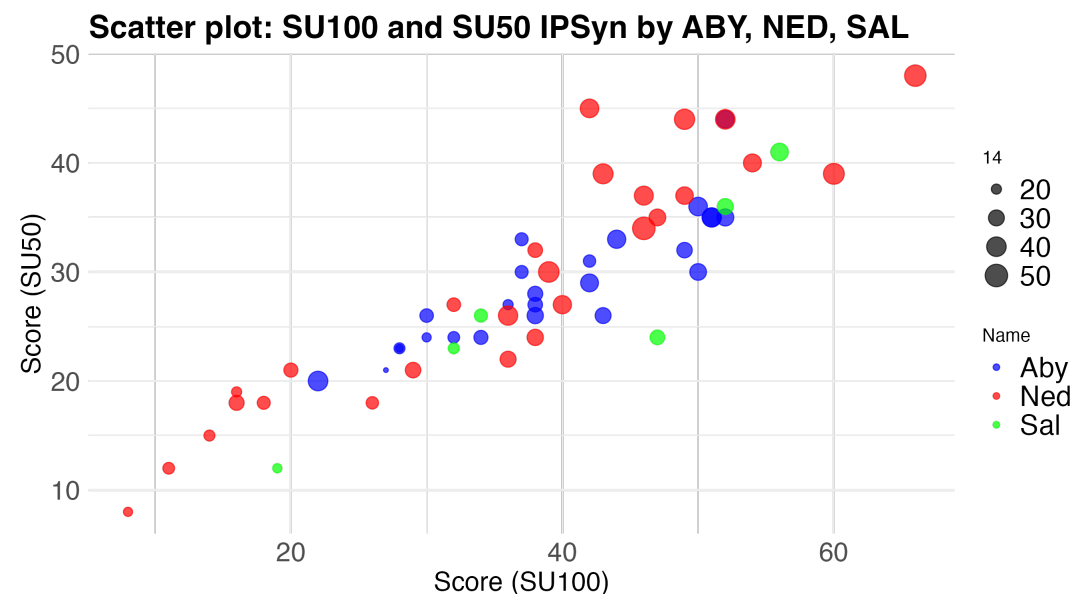


Linear Regression between IPSyn Total (SU100) and Vocabulary (lmer)							
	est.	std. error	df	p	r (fixed)	r(fixed+ random)	t
Individual Session	2.781	0.242	71.888	<.001	0.782	0.821	11.478
Cumulative	12.86	1.072	70.172	<.001	0.7	0.874	11.995

# Correlation between IPSyn 50 and IPSyn 100

- 100-utterance and 50-utterance ASL-IPSyn analyses are strongly and significantly related to each other

Each dot represents the IPSyn total score at the same age using IPSyn100 and IPSyn50, dot size represents age.



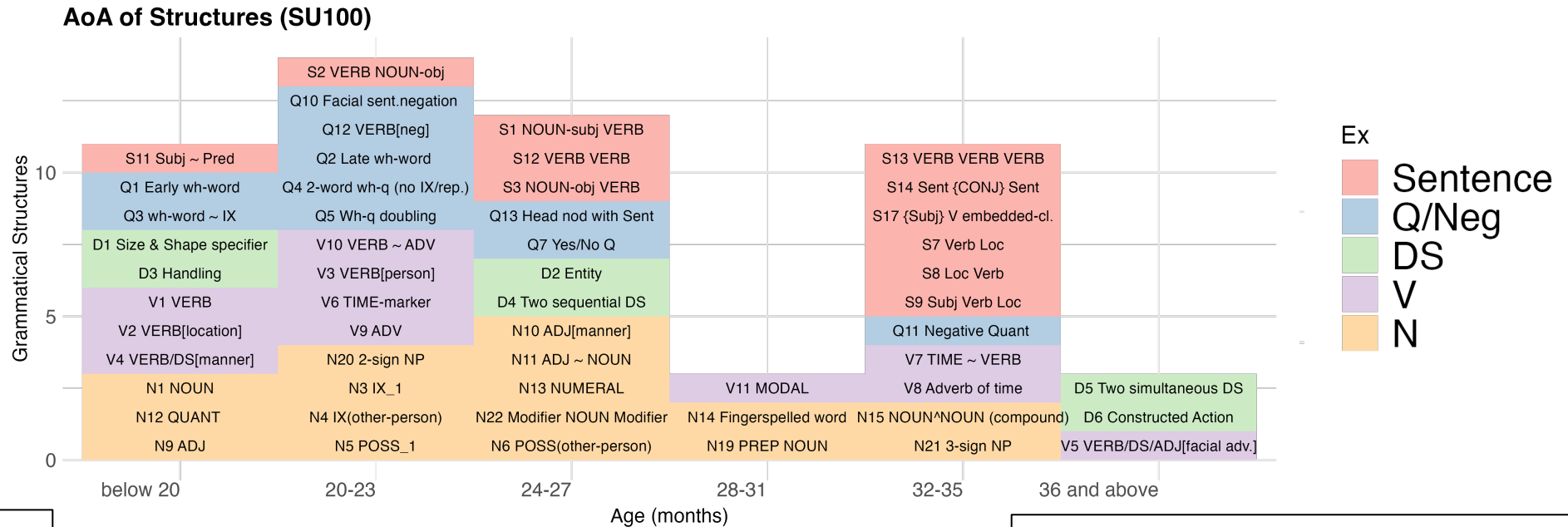
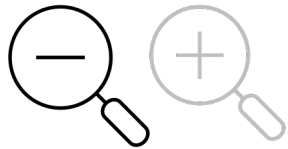
Correlation between SU100 and SU50 IPSyn Total Score (cor.test)					
	df	r	p	t	
ABY	23	0.875	<.001	8.671	
NED	25	0.925	<.001	12.186	
SAL	4	0.918	0.01	4.643	

# Age of Acquisition (AoA) of Grammatical Structures

- Select **common sessions** among the children.
- Determine AoA of each grammatical structure.
  - Identify the **earliest age** of each structure among **at least 2 children**.
- The analysis was done for both IPSyn 100 and IPSyn 50 scoresheets.

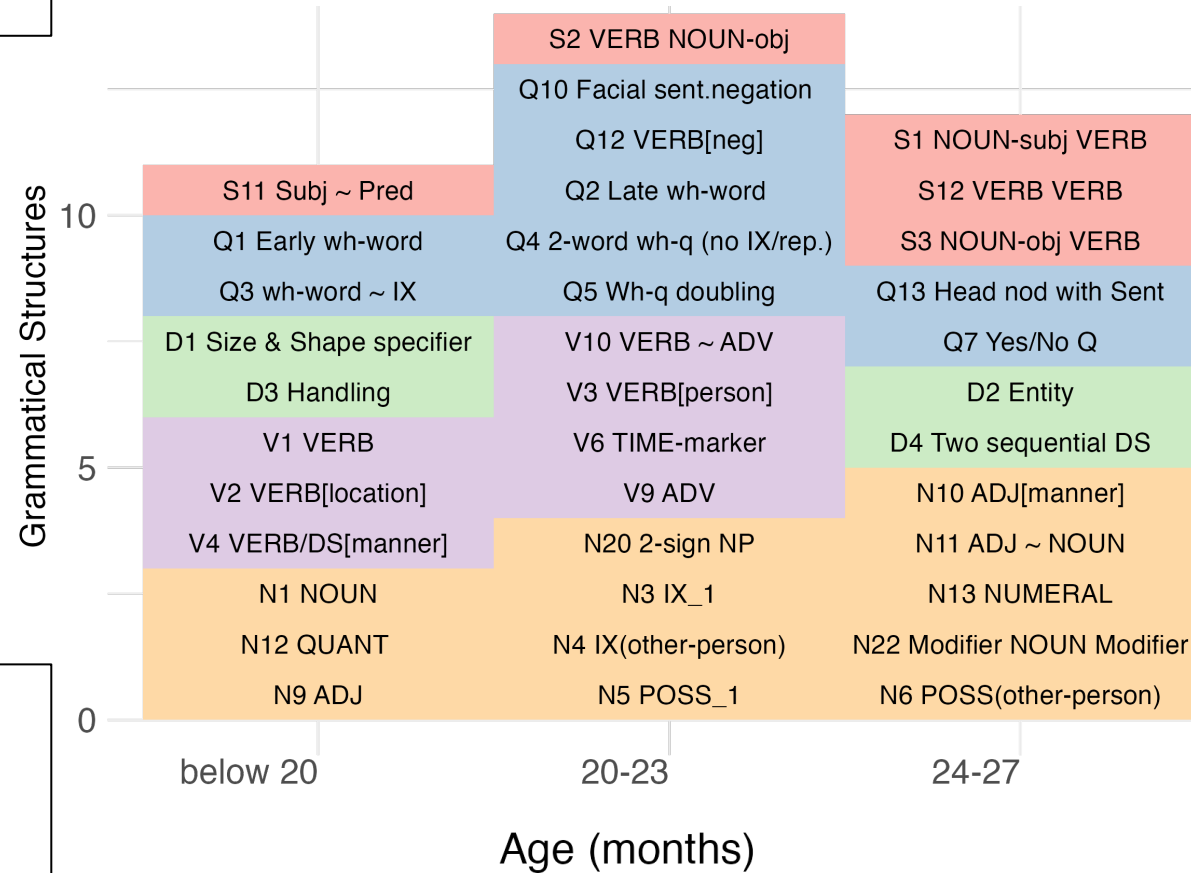
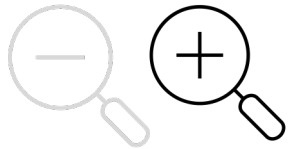
Child	Number of Sessions analyzed		Beginning Age (months)	Ending Age (months)
	100 utterances	50 utterances		
ABY	22	19	19	40
JIL	25	(N/A)	19	43
NED	24	19	19	43
SAL	6	5	19	34
Total	77	41	--	--

# AoA of Grammatical Structures (IPSynyn 100)





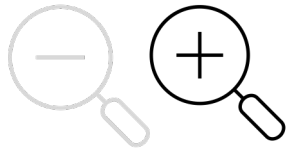
# AoA of Grammatical Structures (IPSyn 100)



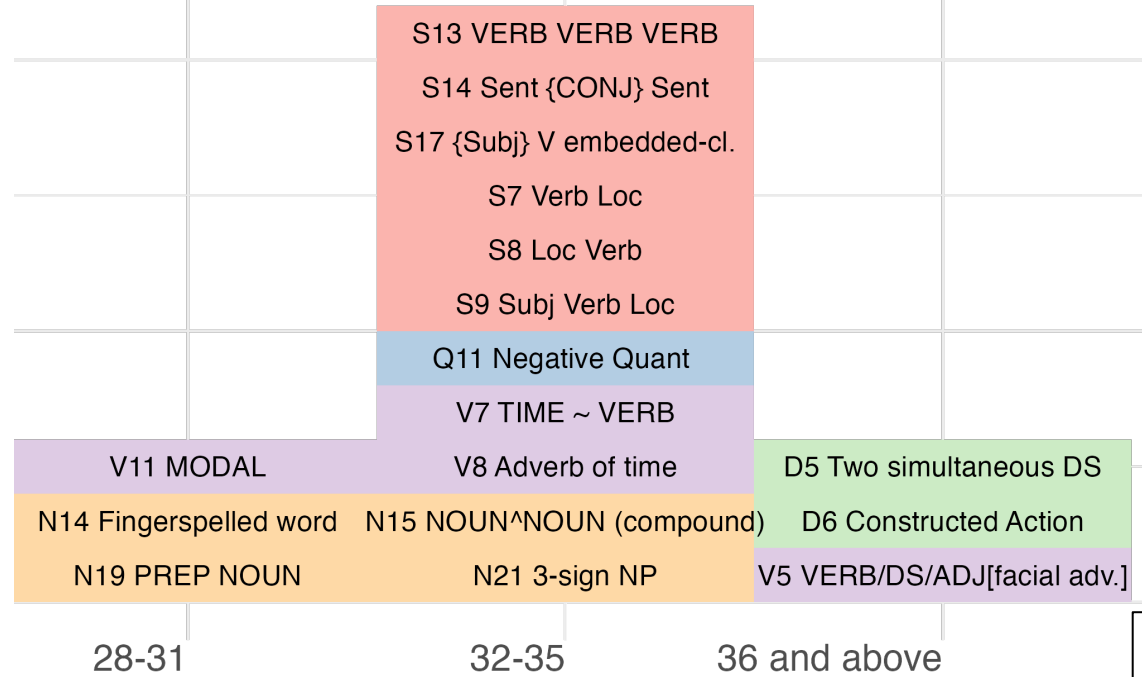
Ex

- Sentence
- Q/Neg
- DS
- V
- N

# AoA of Grammatical Structures (IPSyn 100)



Grammatical Structures



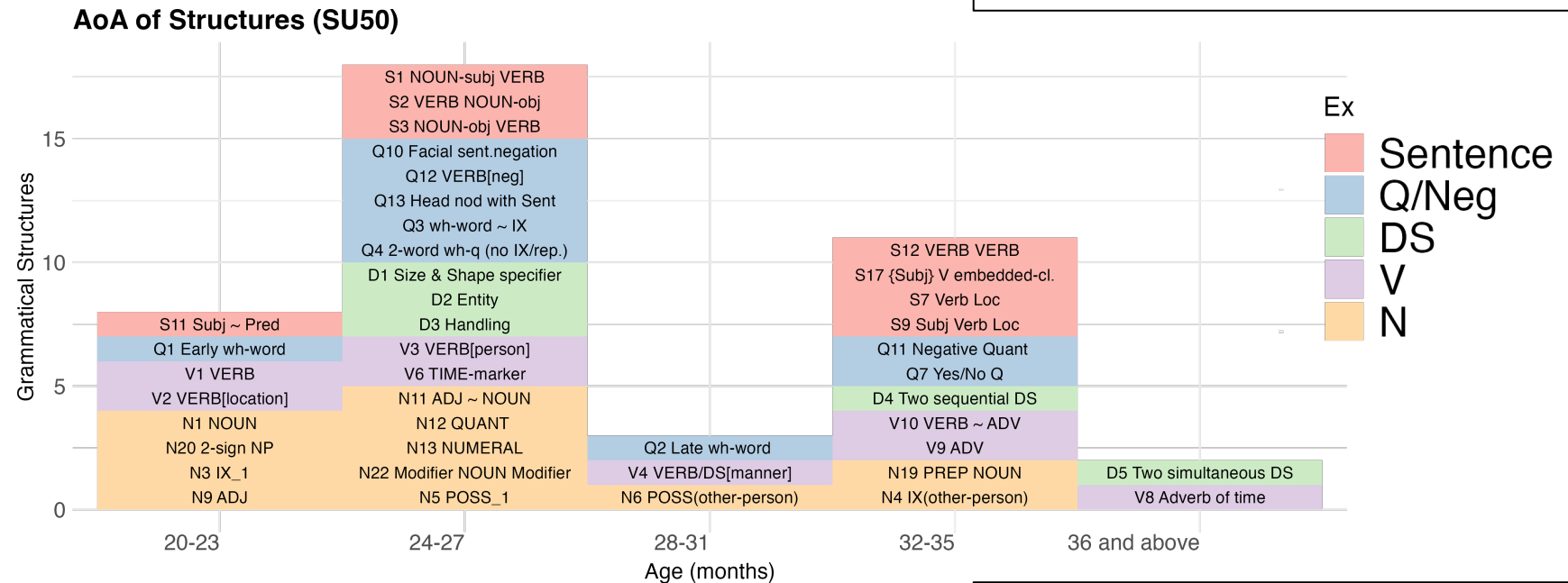
Ex

- Sentence
- Q/Neg
- DS
- V
- N

Age (months)

# AoA of Grammatical Structures (IPSyn 50)

- IPSyn 100 generally shows **earlier AoA**.
  - N1, N3-N6, N9, N12, N19
  - V1-4, V6, V8-V10
  - D1, D3, D4
  - Q1-Q4, Q7, Q10, Q12-13
  - S1, S2, S11, S12



# Age of Acquisition

- Our findings are generally consistent with previous acquisition literature
  - Very early emerging (20 months): nouns, verbs, adjectives; IX; early wh-words; simple Subj~Pred 2-word utterances
  - Later emerging (32 months): 3-sign NPs, embedding
  - Non-manuals for negation and polar questions appear before non-manuals as verb modifiers or in wh-questions

# Age of Acquisition

- However, we see possibly earlier development of some structures
  - Verb modification for location, manner, and person before 24 months (c.f. Meier 1982; Newport & Meier 1985)
  - Handling and SASS Classifiers by 20 months; Entity by 24-27 months (c.f. Kantor 1980; Schick 1990)
- We also observe many structures which are not widely discussed in the literature



# Example 1

- ABY
- 18m
- Q10: Negative NMM



## Example 2

- NED
- 27m
- V3: Verb agreement



## Example 3

- SAL
- 34m
- V4, V5: Verb modifications
- D3, D6





# Discussion

- ASL IPSyn is strongly related to productive vocabulary development.
- While ASL IPSyn (100) is somewhat more sensitive – allowing for some structures to be observed at younger ages – it is strongly related to scores on ASL IPSyn (50), permitting analysis of less productive / shorter sessions.

# Future directions

- We are working to complete analysis of monthly sessions across the age range available for each child (JIL, SAL).
- Planned statistical analyses: generalized mixed effect model taking into consideration:
  - non-linearity
  - session length for NDW
- Publication will include sharing of all quantitative results for comparison with other researchers' data.

# Conclusions

- ASL IPSyn provides an option for quantitative and qualitative analysis of syntactic development in ASL, as it captures a wide range of details of grammatical development.
- It is appropriate for an in-depth investigation of ASL acquisitional progress

# Acknowledgments

- We are extremely grateful to the participants in this study and their families, who shared so much with us. 🙌
- We are also grateful to the many research assistants who contributed to building the SLAAASh corpus, and those who helped develop earlier versions of the ASL IPSyn measure, especially Sara Schley, Doreen Simons, Corina Goodwin, and Lee Prunier.

# Funding

- Research reported here was supported in part by the National Institute on Deafness and other Communication Disorders of the National Institutes of Health under Award Numbers DC00183, DC013578, and DC016901.
- The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institutes of Health.



# Thank you!

Diane Lillo-Martin: [diane.lillo-martin@uconn.edu](mailto:diane.lillo-martin@uconn.edu);

Linghui Eva Gan: [linghui.gan@uconn.edu](mailto:linghui.gan@uconn.edu)

# Syntactic Unit

- Syntax – “The largest linguistic unit that is held together by rigid grammatical rules” (Track, 1999:273).
- Semantic – “A combination of words expressing a complete thought and making complete sense” (Gartside, 1981:239)
- Prosodic – Sentences breaks can be indicated by a single, or some combination of the following prosodic cues: lowered hands, a pause, lengthening of a sign, a hold, a blink, a nod, a change in eyebrow height, and/or a shift in head or body position.
- See Fenlon et al. (2007) & Crasborn (2007) for more discussion.

# Results – IPSyn and MLU

